

Nanoethics

An introduction

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Course NANO 310, August–September 2019

Where to find this talk: www.andreasaltelli.eu

Andrea
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CAETERIS ARE
NEVER PARIBUS

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... and these are 6 m worth watching from Slavoj
Žižek [youtube.com/watch?v=TVwKjG...](https://www.youtube.com/watch?v=TVwKjG...)

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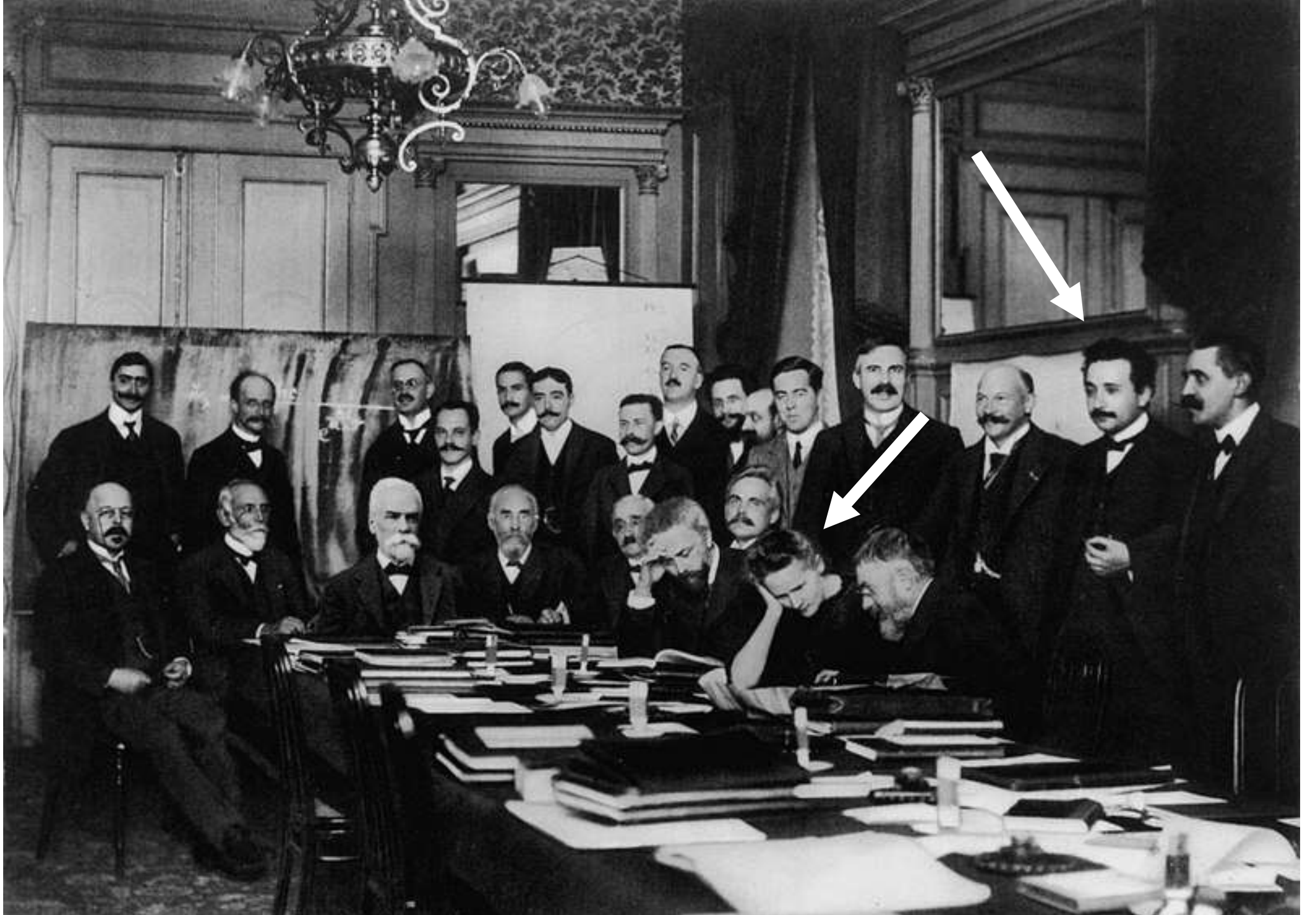


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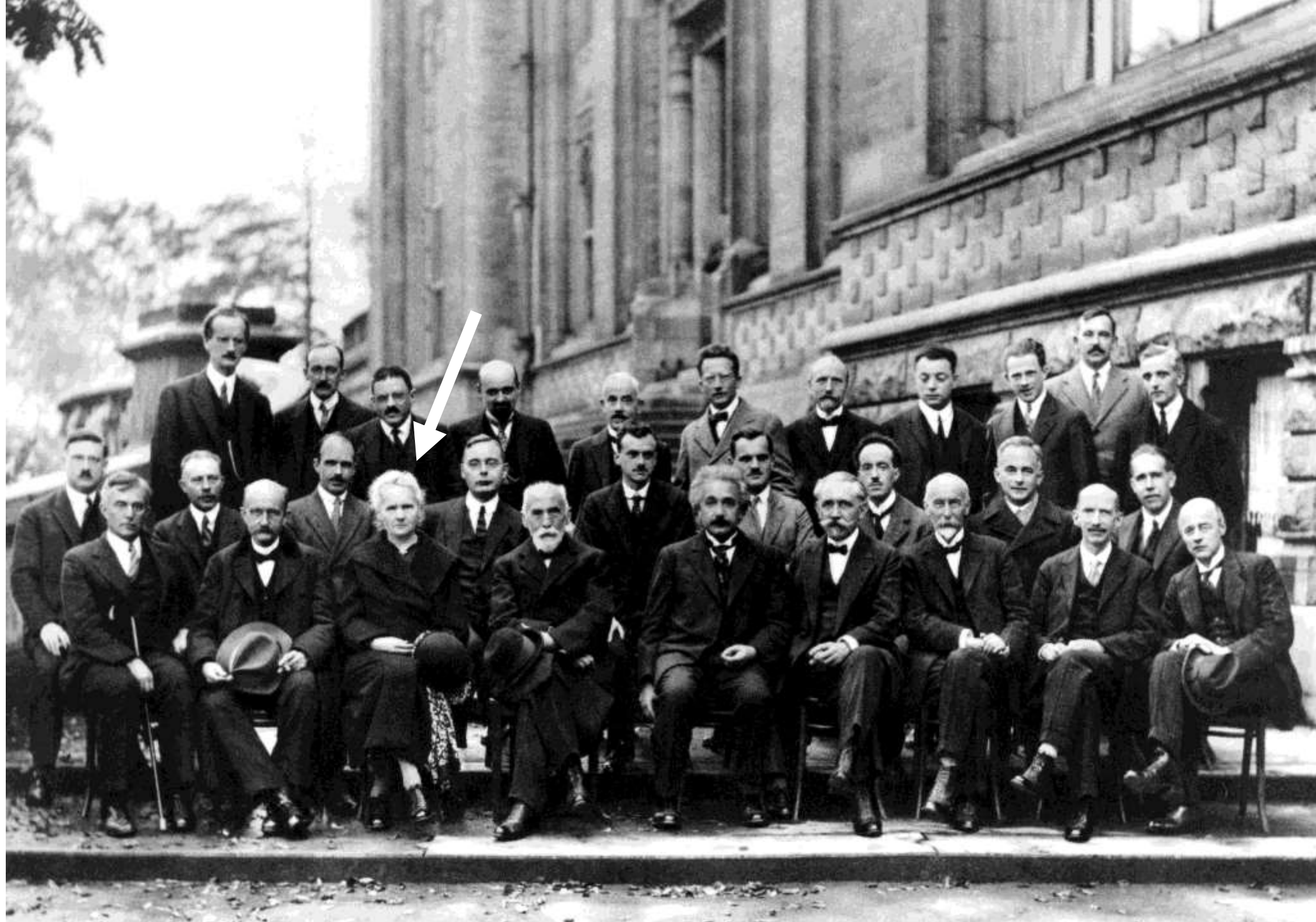
12:33
29/07/2019

So many men, so
few women

1911



1927



Lise Meitner

The first person to understand
nuclear fission;

She did not win the Nobel
prize 1944 for chemistry
which went to her colleague
Otto Hahn



Lise Meitner
1878– 1968

Rosalind Elsie Franklin

Her X-ray images led to the discovery of the DNA double helix structure;

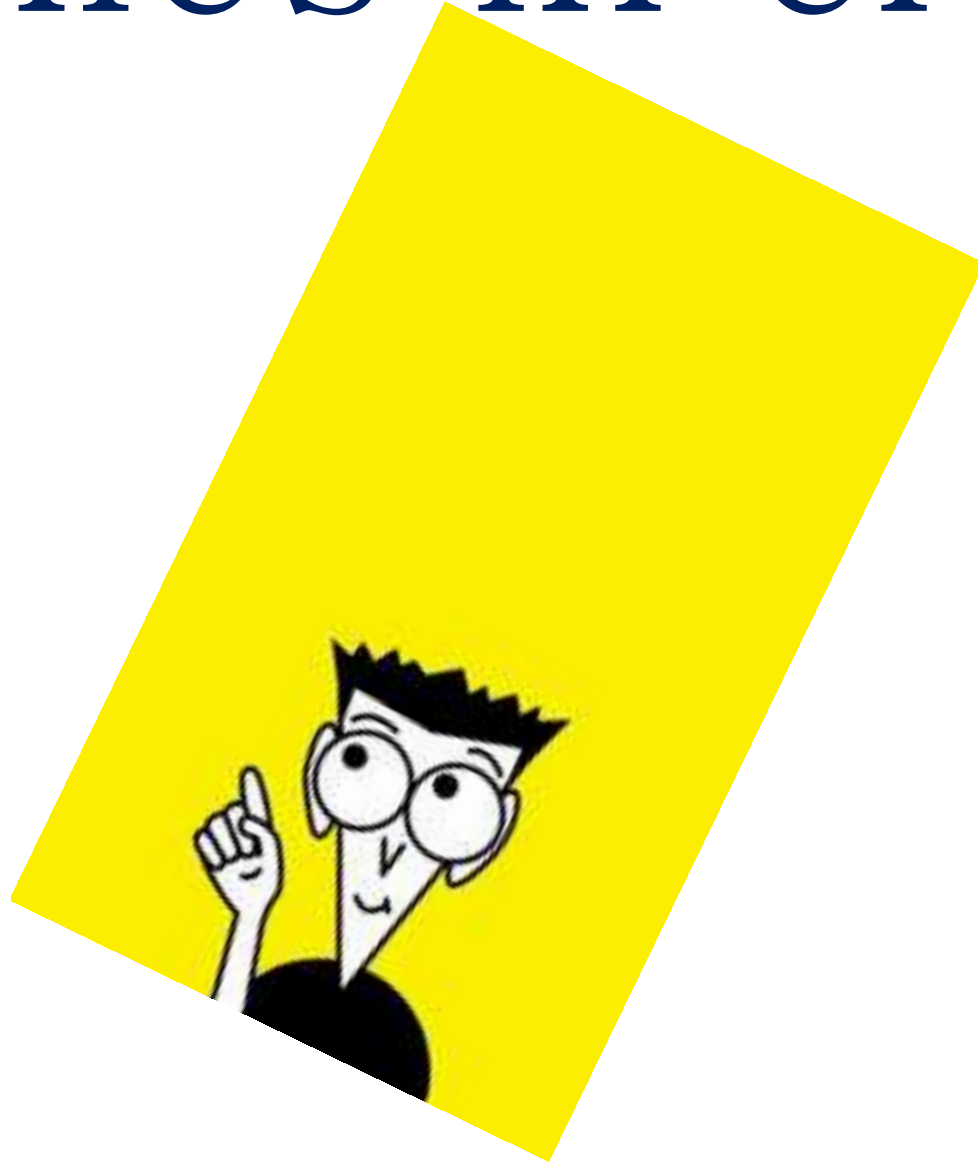
Nobel in Medicine 1962 to J. Watson, F. Crick and M. Wilkins;

Franklin should have ideally been awarded a Nobel Prize in Chemistry (according to J. Watson)



Rosalind Elsie
Franklin
1920–1958

Ethics in crumbs



Philosophical quests:

Ontology: what is

Epistemology: how to know

Ethics: what to do

Question:
which
comes
first?



Golden rule

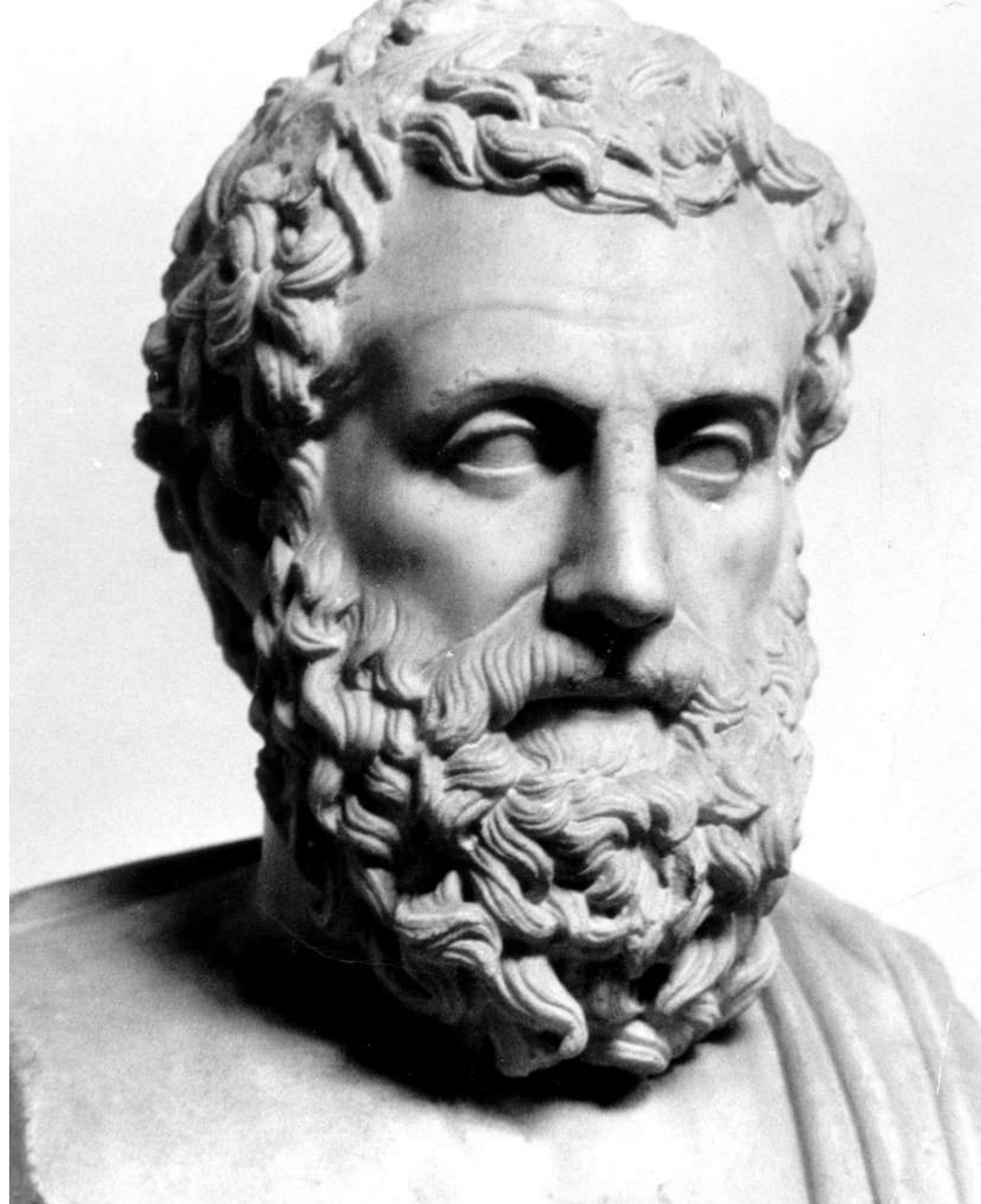
“treat others as you treat yourself” (Mahābhārata, ~IX–V century BCE)

“Avoid doing what you would blame others for doing” (Thales ~624 BC, ~546 BC)

“Treat your inferior as you would wish your superior to treat you” (Seneca, ~4 BC, 65 AD)

“Thou shalt love thy neighbour as thyself”, (Paul the apostle, ~5, ~64 AD)

Aristotle's Nicomachean Ethics



For Aristotle (384, 322 BC) strict relation between ethics and politics

Ethics: How to live a good life (myself)

Politics: How to promote a good life (in the polis)

“...though it is worth while to attain the end merely for one man, it is finer and more godlike to attain it for a nation or for city-states. These, then, are the ends at which our inquiry aims, since it is political science, in one sense of that term”, Book 1, Chapter 2

Ethics for educated citizens [Athenians], no children, no barbaroi, no slaves or craftsmen, no idiots, no women, [but their happiness important]

Unlike in Plato, there is no universal good (no summum bonum)

As the function of man is intellectual activity, his 'good' must be plural and coincide with the exercise of virtues (aretas), among which justice is key

Question: which are the other three virtues?



Happiness descends from the living of a good life;
eudaimonia corresponds to being good to the polis
(ethics and politics together here)

εὐδαιμονία

The concept of eudaimonia has lost little of its appeal; see e.g. Jeffrey Sachs and the World Happiness Report...

Figure 2.7: Ranking of Happiness 2016-2018 (Part 1)

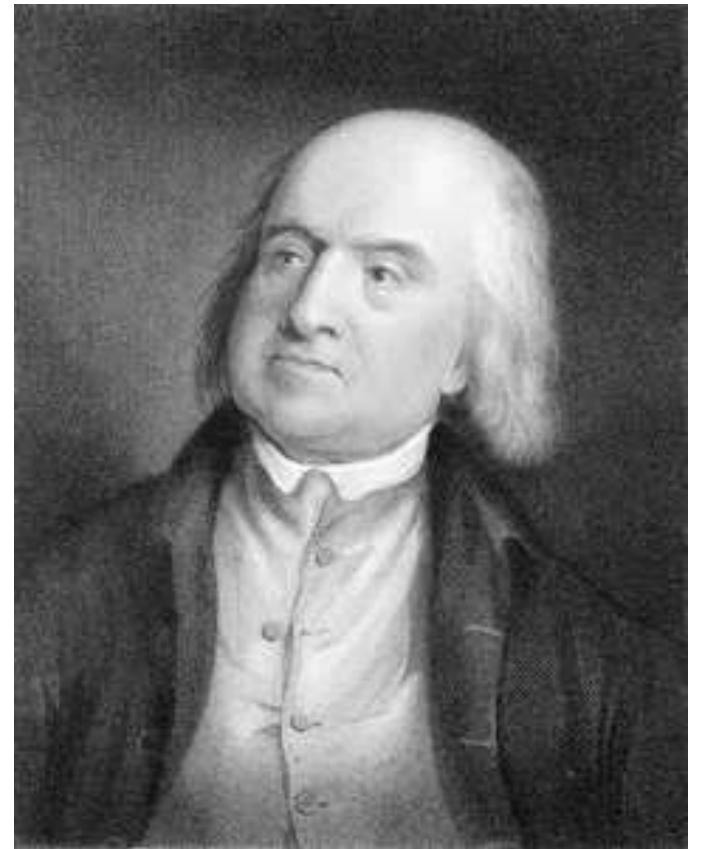


εὐδαιμονία

Fast forward some 22 centuries

Jeremy Bentham's fundamental
axiom

"it is the **greatest** happiness of the
greatest number that is the
measure of right and wrong"



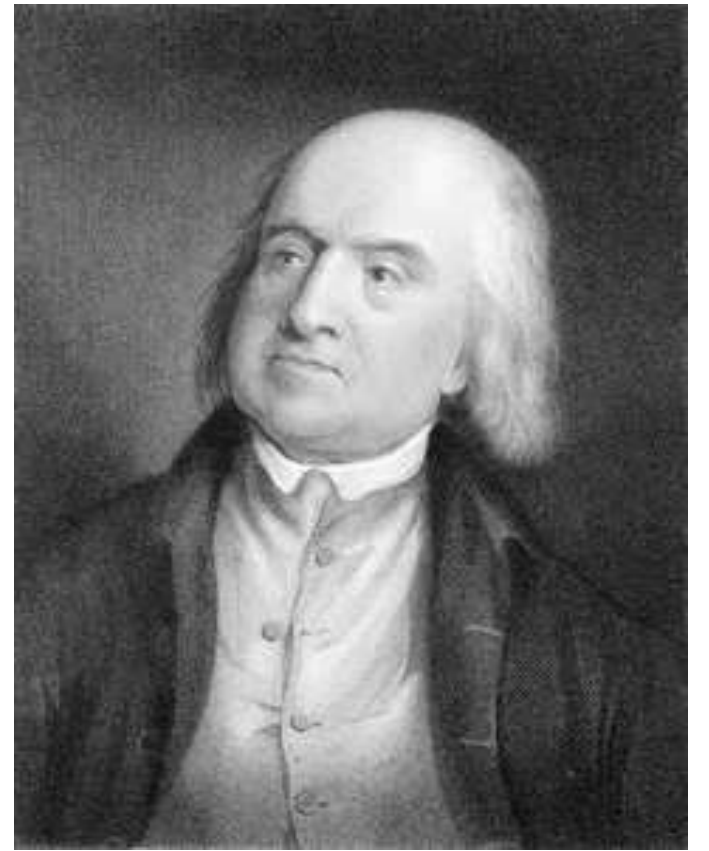
Jeremy Bentham
(1748, 1832)

The long lasting influence of
utilitarianism, e.g. today in economics;

Implies computing the greatest
happiness for the greatest numbers

From Condorcet's *mathématique sociale*
to today's cost benefit analyses

(decisionism, procedural utopia,...)



Jeremy Bentham
(1748, 1832)

A jump into nano

An introduction to nano-risks, nano- imaginaries, fiction



Late Lessons from Early Warnings: The case of nanotechnologies

Environmental issue report No 22

Late lessons from early warnings: the precautionary principle 1896—2000

2001

Late lessons from early warnings:
science, precaution, innovation

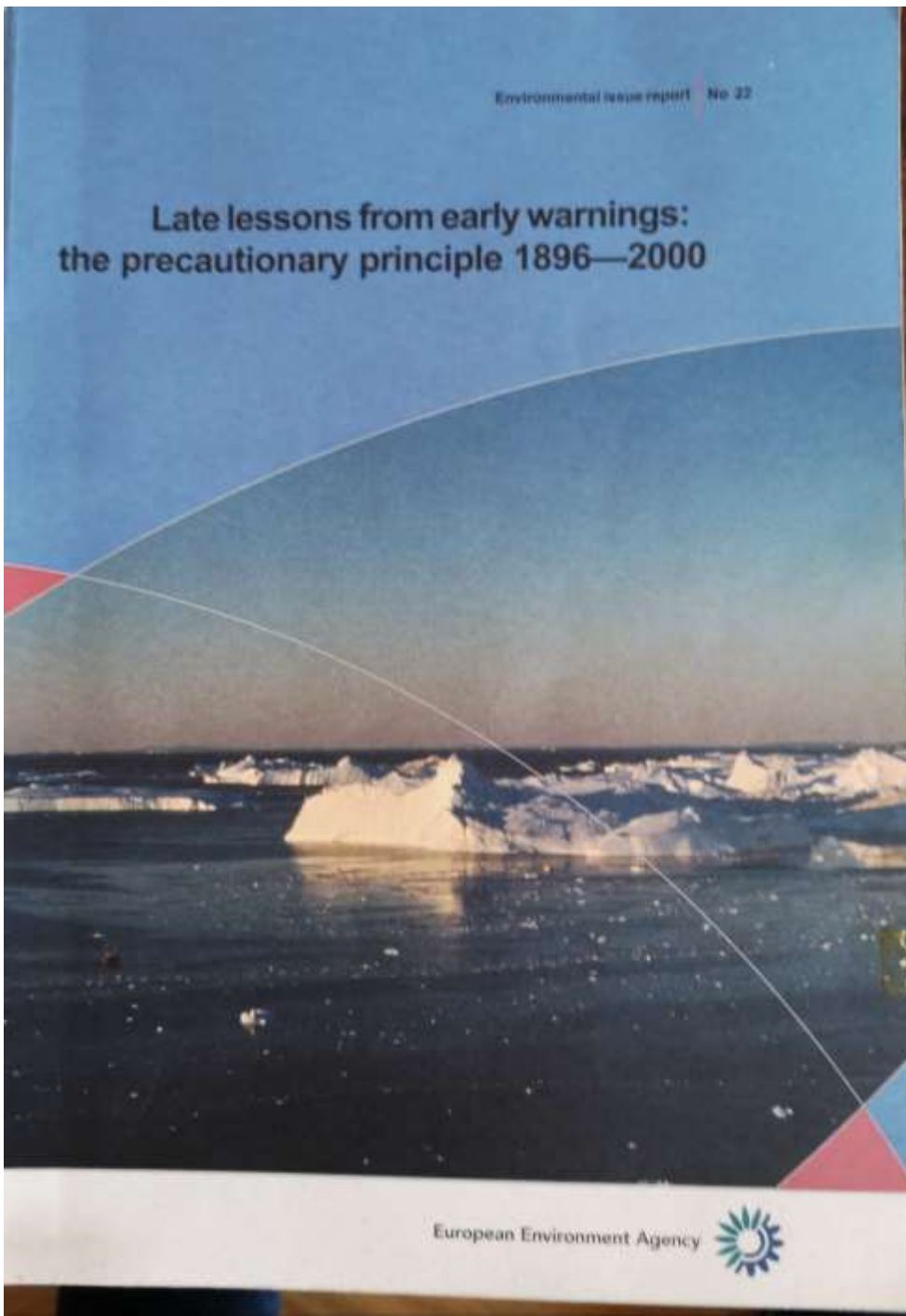
Summary

ISSN 1725-9177



2013





2001

https://www.eea.europa.eu/publications/environmental_issue_report_2001_22/Issue_Report_No_22.pdf/view

European Environment Agency (EEA, 2001):
Late Lessons from Early Warnings. The Precautionary
Principle 1896–2000

14 case studies of how not heeding early
warnings led to catastrophe

Asbestos, chlorofluorocarbons, non-ionizing radiation
and ‘mad cow disease’, leading to

➔ 12 “late lessons”

Late lessons from early warnings:
science, precaution, innovation

Summary

ISSN 1725-9177



2013

<https://www.eea.europa.eu/publications/late-lessons-2>

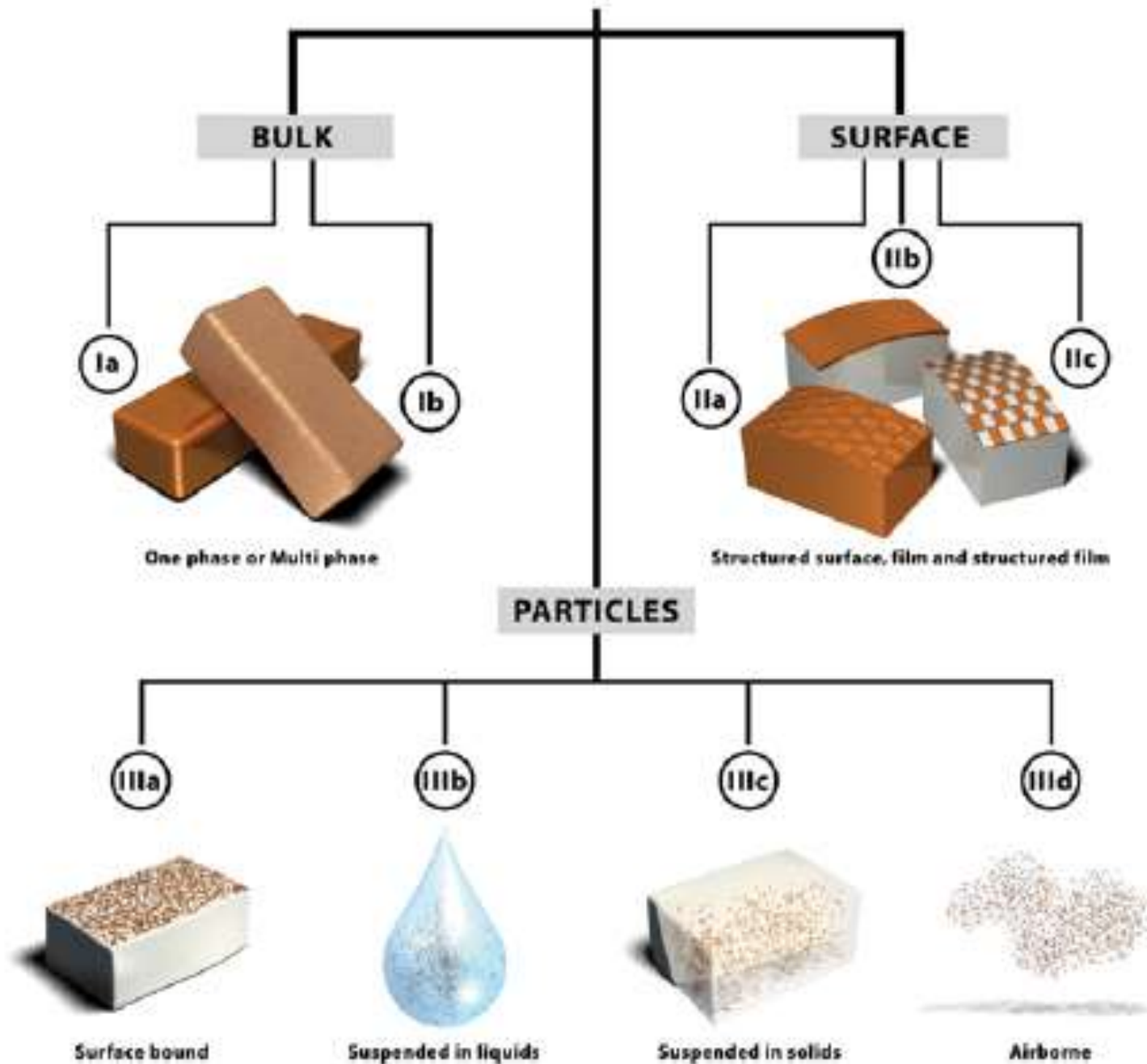


Chapter 22

Nanotechnology: *early* lessons from early warnings



NANOMATERIALS



Categorisation framework for nanomaterials, according to the location of the nanostructure in the material

Source: <http://www.nanotechproject.org/>

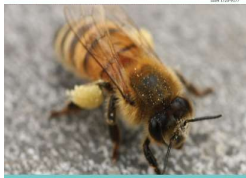
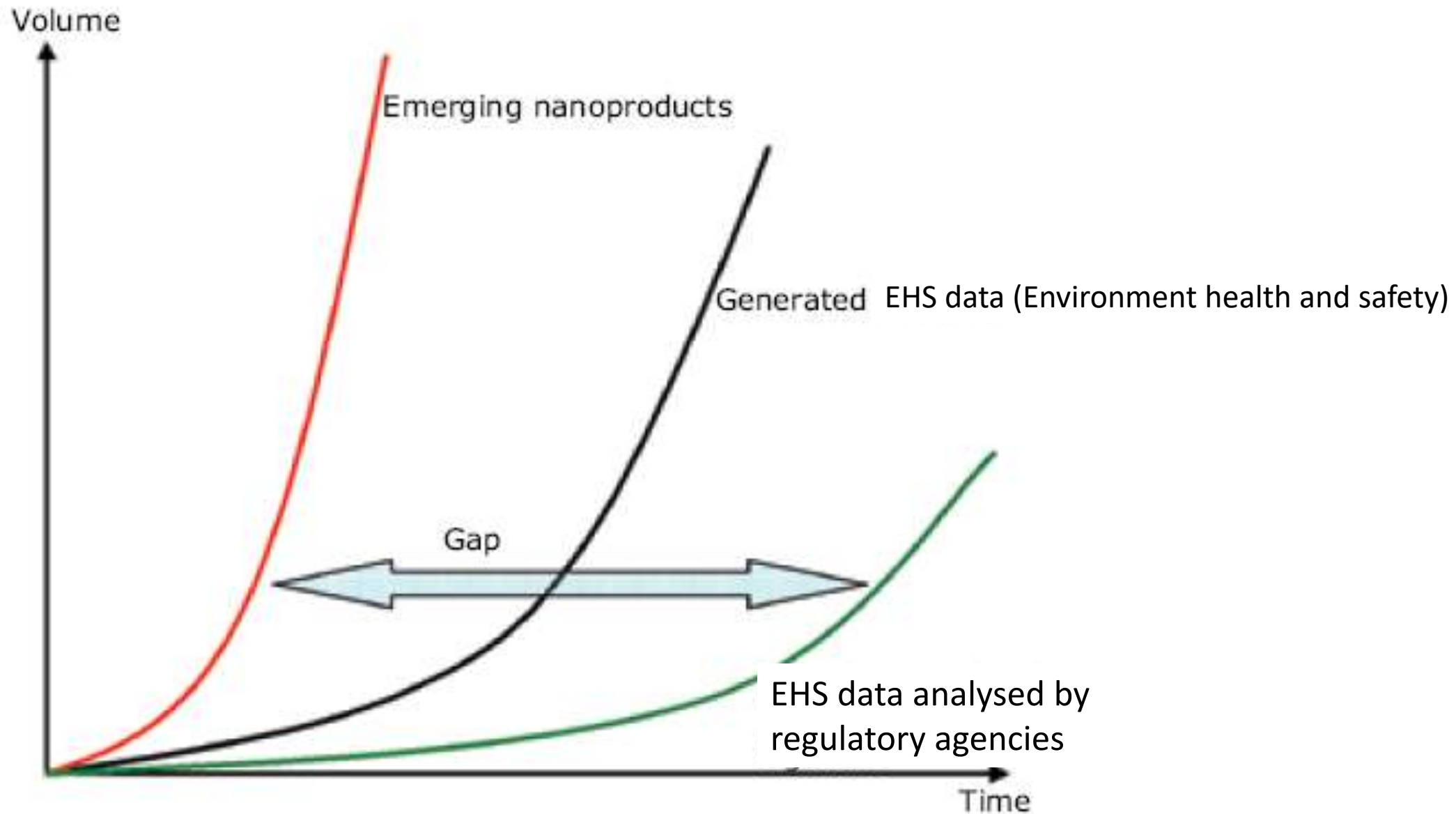


Consumer Products Inventory

An inventory of nanotechnology-based consumer products introduced on the market.



Emergence of nanotechnology products in comparison to generated EHS data



This is the old Collingridge Dilemma:

Can we control the development of a technology?

Impacts cannot be easily predicted until the technology is developed and taken up...

... But change is difficult when the technology has become entrenched.

Collingridge, D. 1980, *The Social Control of Technology* (New York: St. Martin's Press; London: Pinter)

No data, no market principle (REACH)

REACH Regulation (2006) to protect human health and the environment.

Incorporates the precautionary principle.

Though present legislation might fail to differentiate between nano-based products and their conventional counterparts.

Toxicity, bioaccumulation and persistence

Nano(eco) toxicity

Analogies of nano particles with ambient ultrafine particles and asbestos.

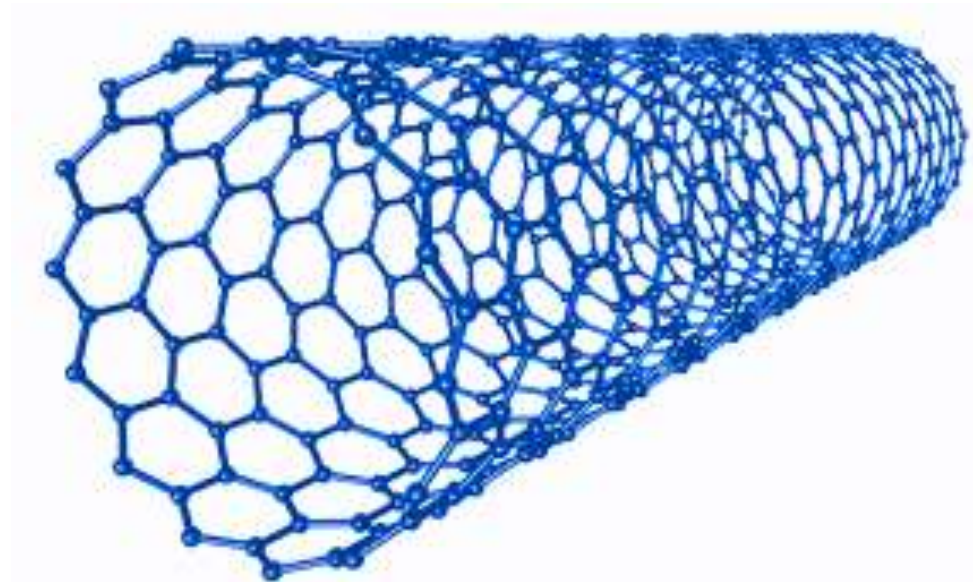
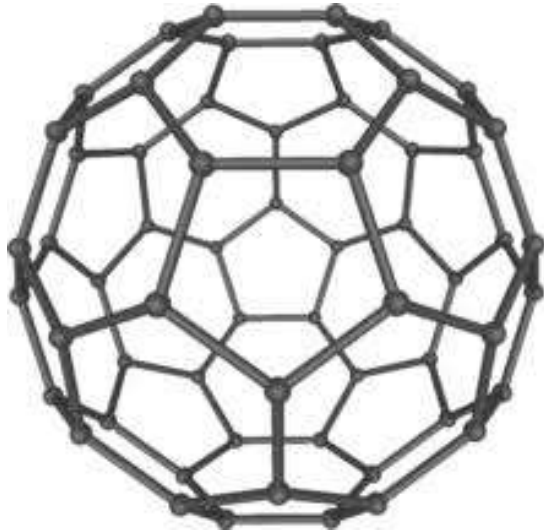
Ultrafine TiO_2 and Al_2O_3 of 30 and 20 nm, respectively, produce inflammation in rats.

Surface area a better descriptor than mass for the adverse effects.

Toxicity, **bioaccumulation** and **persistence**

Both fullerenes and nanotubes are persistent but little is known about bioaccumulation

There are 50,000 possible combinations of single carbon walled nanotubes with potentially different properties; hard to assess toxicity for all.



A comparison between the EEA recommendations made in 2001 and the current [2013] situation for nanotechnology



1. Acknowledge and respond to ignorance, uncertainty and risk in technology appraisal.



2. Provide long-term environmental and health monitoring and research into early warnings.

3. Identify and work to reduce scientific 'blind spots' and knowledge gaps.

➔ Look at “warning signs”: materials novel, biopersistent, readily dispersed, bioaccumulative, lead to irreversible action

(analogy, thousands of mesothelioma caused by the inhalation of asbestos dust)



4. Identify and reduce interdisciplinary obstacles to learning.



11. Identify and reduce institutional obstacles to learning and action.

➔ Mind “institutional ignorance”, e.g. from disciplinary blinders: “The Environmental Protection Agency constrained by a world view rooted in chemistry”

(for nano you need physics, chemistry, computer sciences, health and environmental science...)



5. Account for real-world conditions in regulatory appraisal.



8. Ensure use of 'lay' knowledge, as well as specialist expertise.

➔ “the future looked a lot like the past with men in grease-stained blue coats [...]”

(it is frequently those who make and use a product that have ideas about what is important and what works and what does not)



6. Systematically scrutinize claimed benefits and risks.



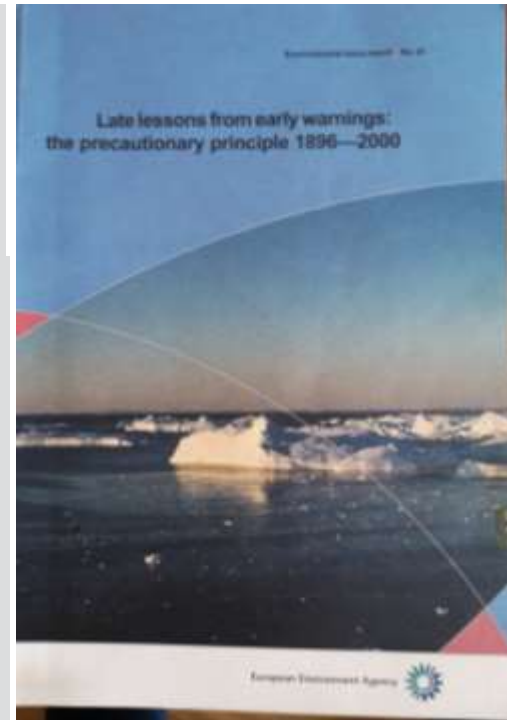
9. Account fully for the assumptions and values of different social groups.

➔ Look at pros and cons; if ‘pros’ do not materialize, or ‘cons’ later prove significant = public trust can be compromised

(Mad cow disease: disgust of public opinion to learn of cows fed on offal and bodily waste)



7. Evaluate alternative options for meeting needs, and promote robust, diverse and adaptable technologies.



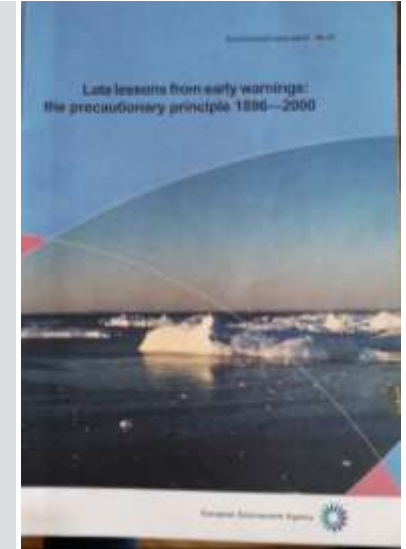
➔ Not because it can be done it should be done



**"Move fast and break things.
Unless you are breaking stuff,
you are not moving
fast enough."**

-Mark Zuckerberg

10. Maintain regulatory independence of interested parties while retaining an inclusive approach to information and opinion gathering.



12. Avoid 'paralysis by analysis' by acting to reduce potential harm when there are reasonable grounds for concern.

➔ Be alert of regulatory capture;
exaggerating uncertainty can be used
to deflect regulation

(Mad cow disease: disgust of public
opinion to learn of cows fed on offal and
bodily waste)



“A comparison between the EEA recommendations made in 2001 and the current [2013] situation for nanotechnology shows that stakeholders are doing some things right, but we are still in danger of repeating old, and potentially costly, mistakes”

EEA conclusions: doing enough?

The question seems not to be whether we have learnt the lessons, but whether we are applying them effectively enough to prevent nanotechnology being one more future case study on how not to introduce a new technology

Despite a good start, it seems that we have become distracted



Other views and concerns
for an ethics of
nanotechnologies

Dutch view: RIVM 2014



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Assessing health
& environmental
risks of
nanoparticles
An overview

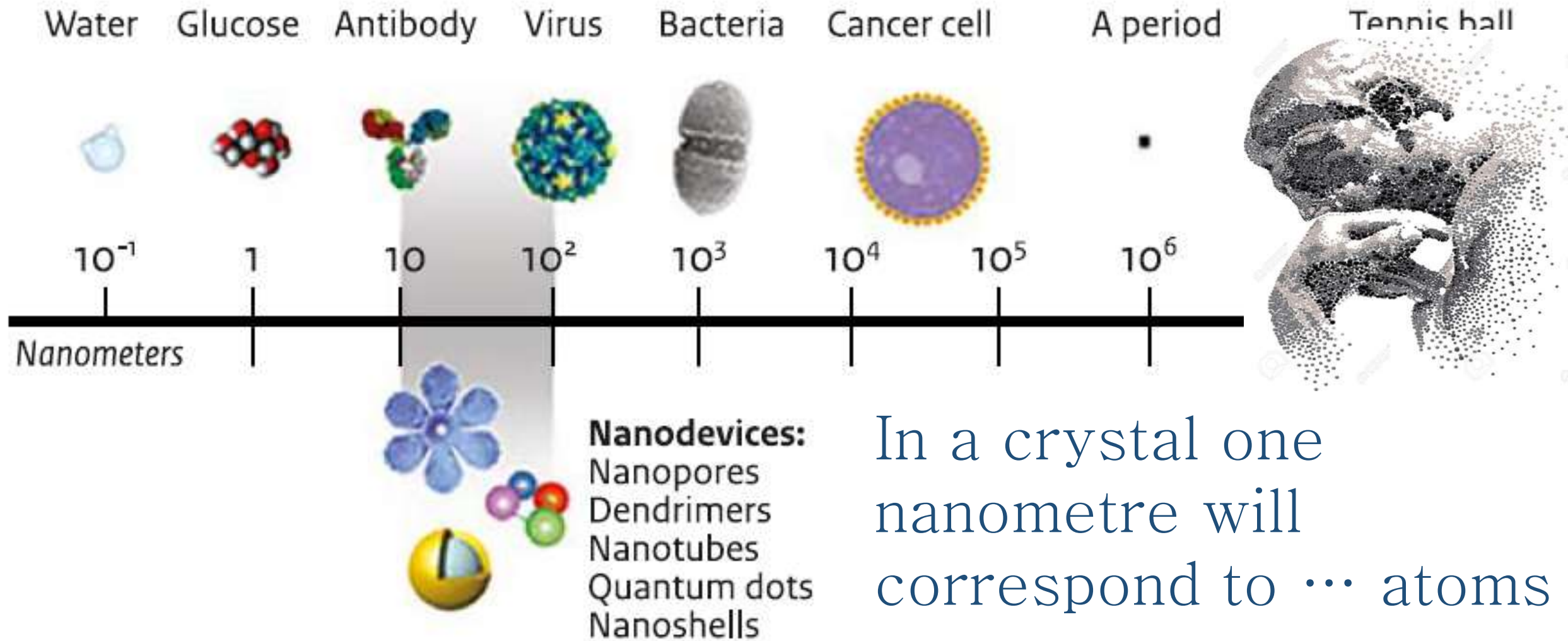


Source: E.A.J. Bleeker, S. Evertz, R.E. Geertsma, W.J.G.M. Peijnenburg, J. Westra, S.W.P. Wijnhoven, Assessing health & environmental risks of nanoparticles. Current state of affairs in policy, science and areas of application, RIVM Report 2014-0157, <http://www.rivm.nl/bibliotheek/rapporten/2014-0157.pdf>

Summary version: Jaco Westra (editor), 2014, Assessing health and environmental risks of nanoparticles. An overview, RIVM Rapport 2014-0157, https://www.rivm.nl/sites/default/files/2018-11/007767_nanoparticles_eng-tg.pdf



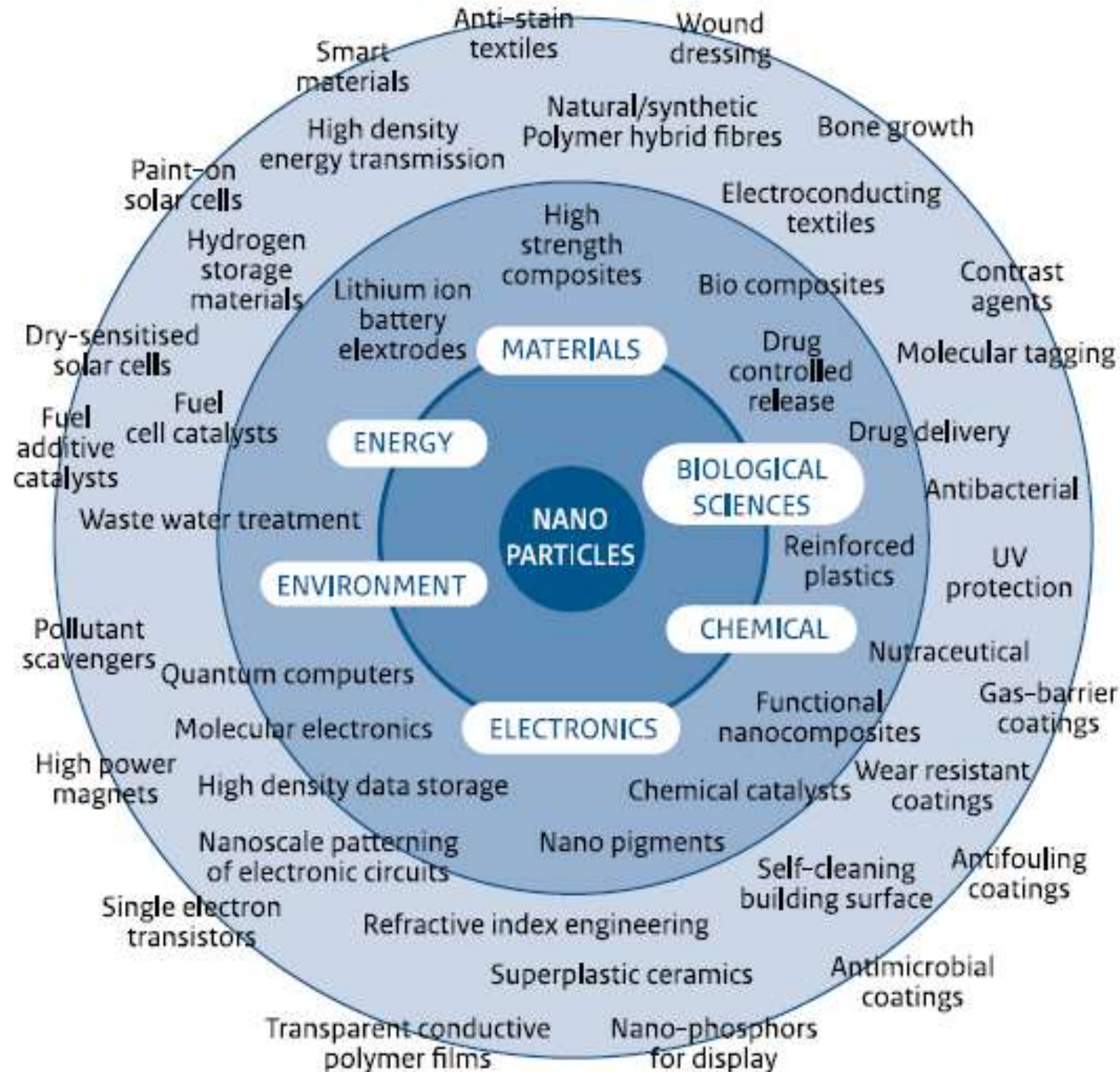
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and the Environment
Ministry of Health, Welfare and Sport



In a crystal one nanometre will correspond to ... atoms



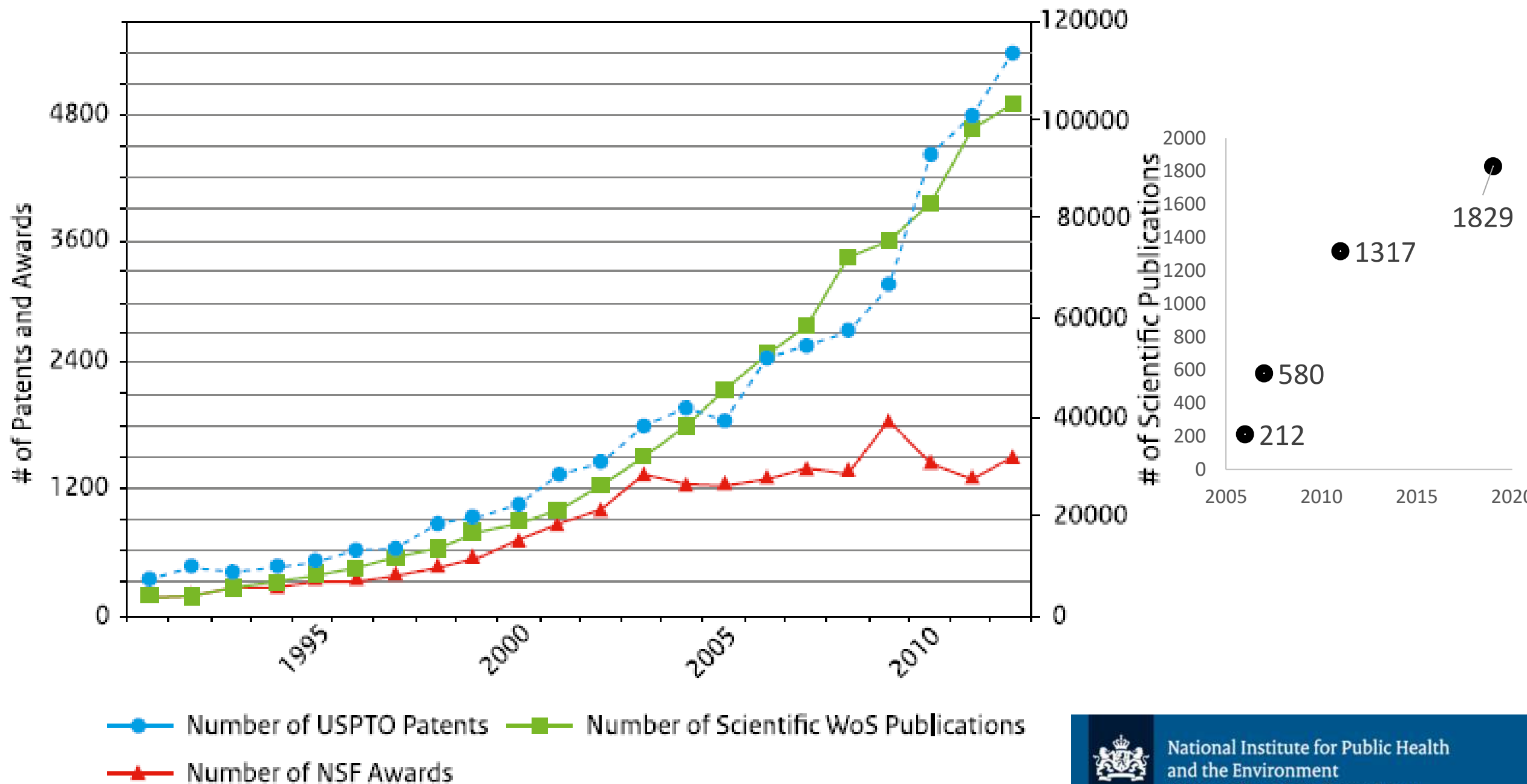
National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport



Source: McDermott, Will and Emery, 2014. 2013 Nanotechnology Patent Literature Review. McDermott, Will and Emery.



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport



Findings: Nanotoxicology developing but unable to cope with existing volumes;

Extending present chemical testing to nanomaterials inadequate;

Need for balancing safety and economic feasibility with innovation; “Safe-by-design?” this concept can too easily be interpreted as balancing risk or hazard and functionality



Policy: in the EU nanotechnology is one of the five KET, Key Enabling Technologies; with microelectronics and nanoelectronics (including semiconductors), photonics, advanced materials, and biotechnology

In the US the National Nanotechnology Initiative Strategic Plan (NSTCCT, 2014)



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

How to cope: Need for generalized, grouping approaches, such as a nanoparticle-specific QSAR Quantitative structure activity relationship, computer based predictions...

Activities ongoing in Scientific Committee on Consumer Safety (e.g. cosmetics), Scientific Committee of Emerging and Newly Identified Health Risks (e.g. on nano-silver), REACH (TiO_2) and EFSA (food additive) but legislative gaps exists.



Concerns

- Consumers not informed;
- No regulatory incentive for manufacturers to make data available;
- Measuring techniques expensive;
- Too many products too quickly compared to pace of risk analyses
- Adaptation of regulators (e.g. REACH) slow and with gaps





SANTA CLARA UNIVERSITY
THE JESUIT UNIVERSITY IN SILICON VALLEY

Andrew Chen, 2002, The Ethics of Nanotechnology,
Markkula Center for Applied Ethics, May 3, 2002,

<https://www.scu.edu/ethics/focus-areas/technology-ethics/resources/the-ethics-of-nanotechnology/>

Manufacturing

Precision Manufacturing

Material Reuse

Miniaturization

Medicine

Pharmaceutical Creation

Disease Treatment

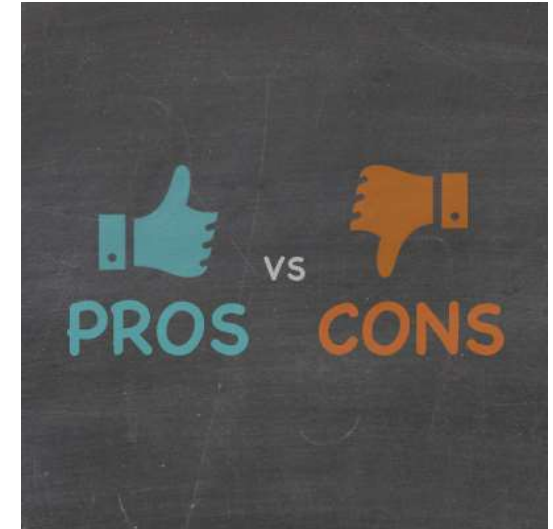
Nanomachine-assisted Surgery

Environment

Toxin Cleanup

Recycling

Resource Consumption Reduction



Markkula Center
for Applied Ethics

Weapons

Miniature Weapons and Explosives

Disassemblers for Military Use

Rampant Nanomachines

Self Replicating Nanomachines

The Gray Goo Scenario

Surveillance

Monitoring

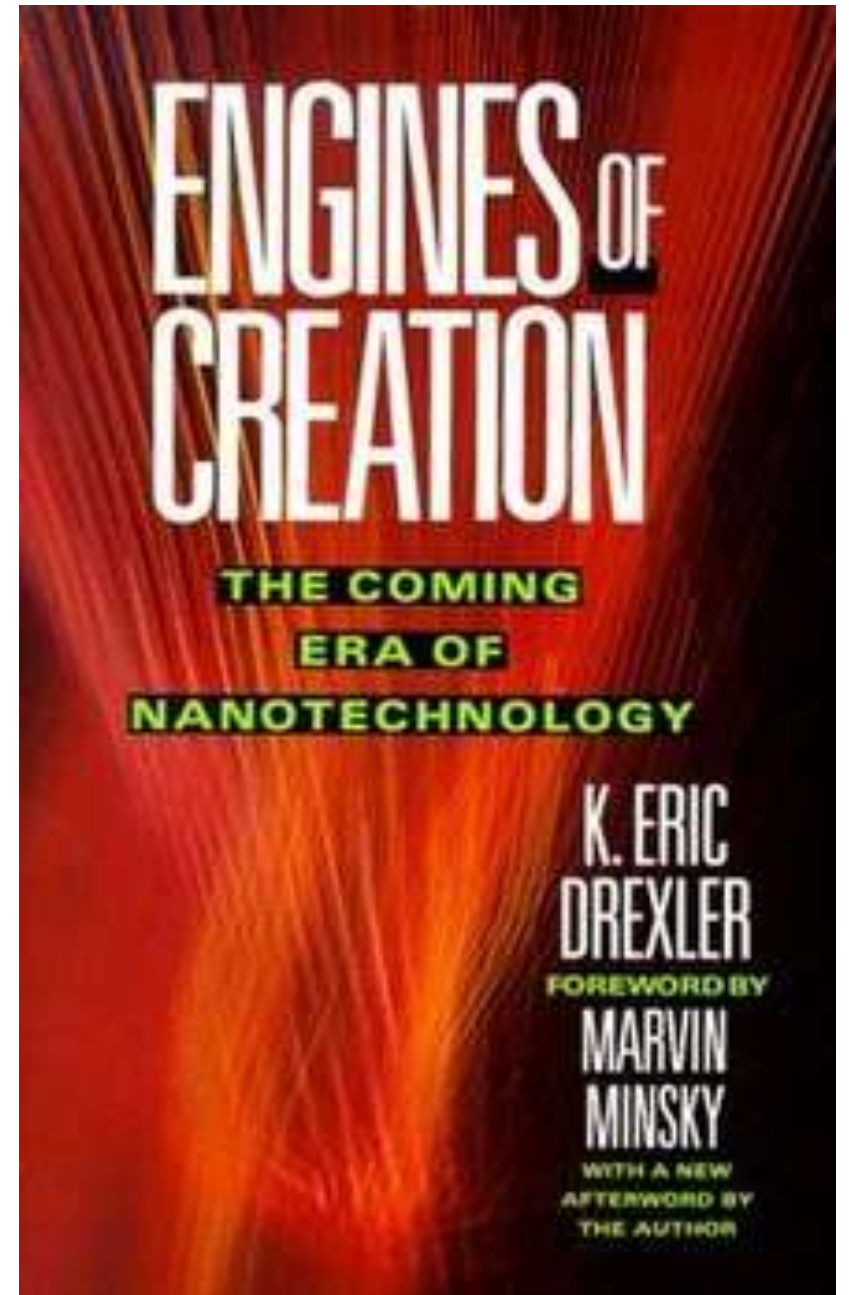
Tracking



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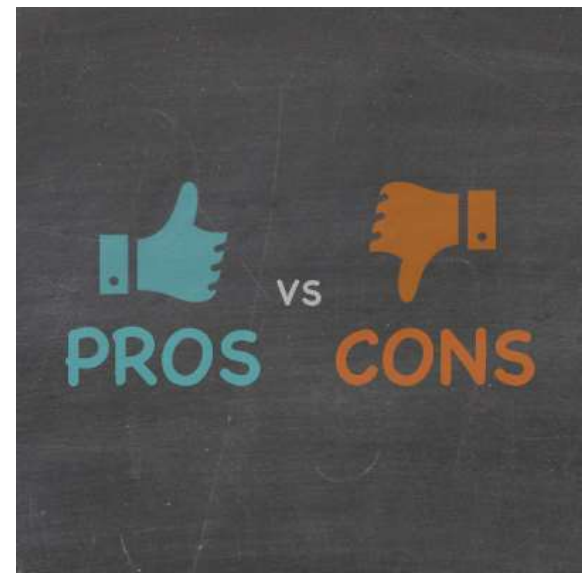
Note: Gray Goo Scenario =
self-replicating robots
consuming all biomass on
Earth while building more of
themselves

<https://foresight.org/>



Possible guidelines

- Nanomachines should only be specialized, not general purpose
- Nanomachines should not be self replicating
- Nanomachines should not be made to use an abundant natural compound as fuel
- Nanomachines should be tagged so that they can be tracked



Against nano for
weapons?

Campaign to stop autonomous lethal
weapons,

<https://www.stopkillerrobots.org/>

Video:

<https://www.youtube.com/watch?v=TlO2gcs1YvM>

Article:

<https://ijermt.org/publication/36/IJERMT%20V-5-5-5.pdf>

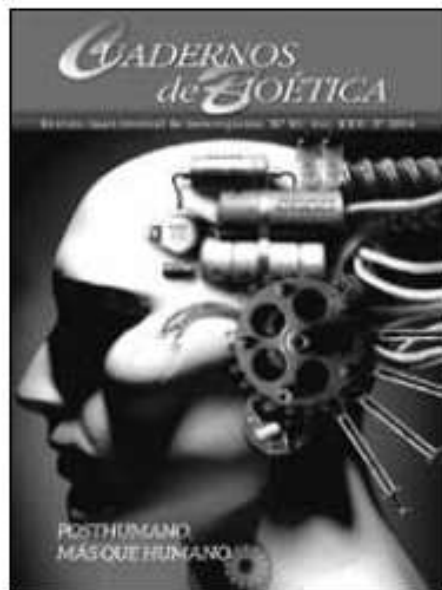
Nano for trans-humanism?

Will GRIN technologies (-geno, -robo, -info, -nano) change the inner constitution of human body?

Nano for trans-humanism?

Cuadernos de Bioética XXV 2014/3ª

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FROM DARWINIAN TO TECHNOLOGICAL EVOLUTION: FORGETTING THE HUMAN LOTTERY

DESDE LA EVOLUCIÓN DARWINIANA A LA TECNOLÓGICA:
OLVIDAR LA LOTERÍA HUMANA

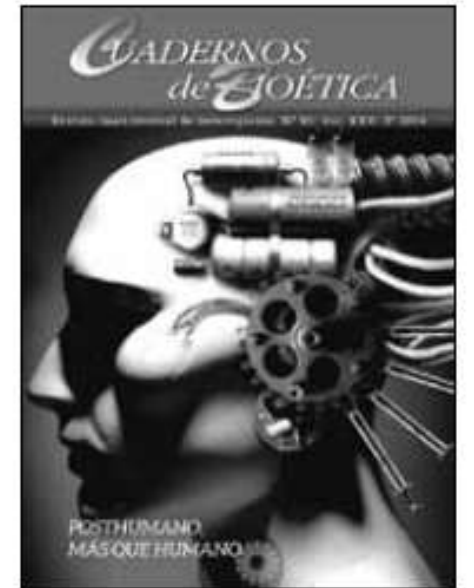
GIORGIO TINTINO

University of Macerata

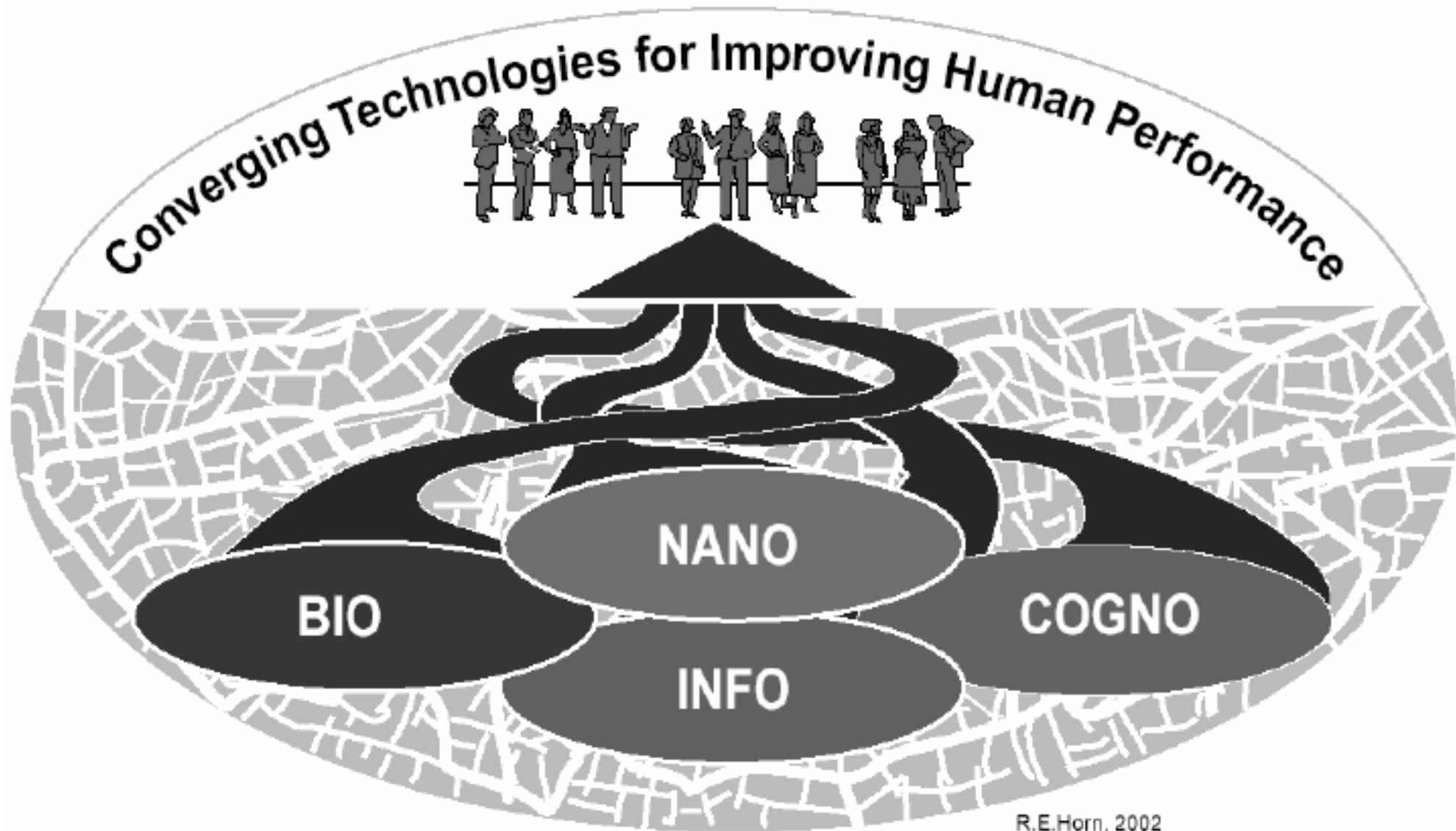
tinto13@alice.it

Nano for trans-humanism?

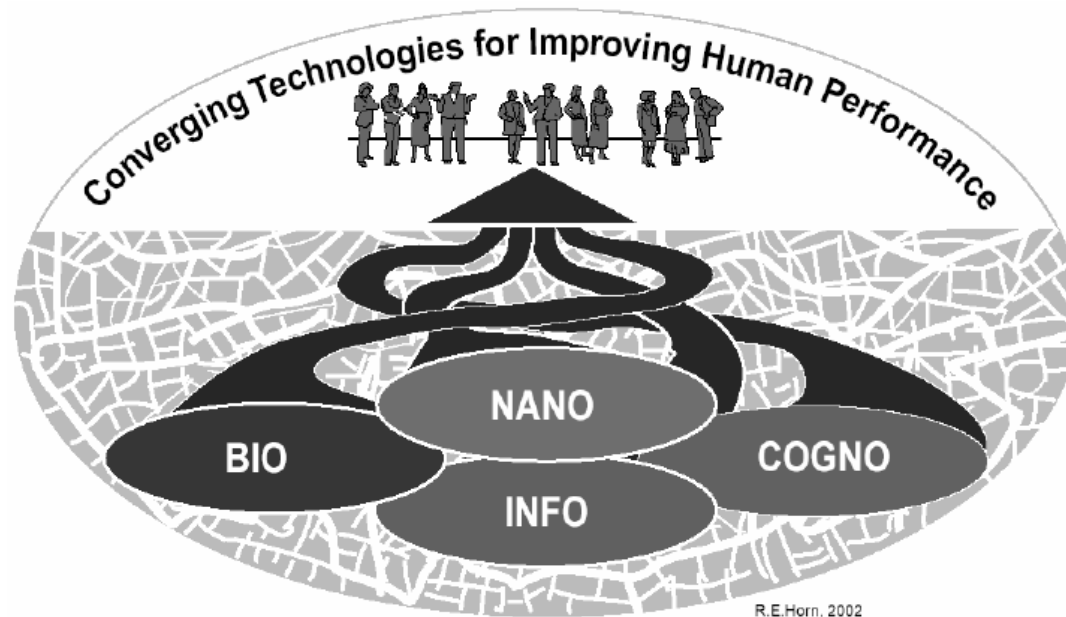
“The human being finds his partner of evolution in technology, a partner who doesn't remain outside his biological constitution but penetrates the inmost of its processes”



A criticized (in the EU) report coming from the US

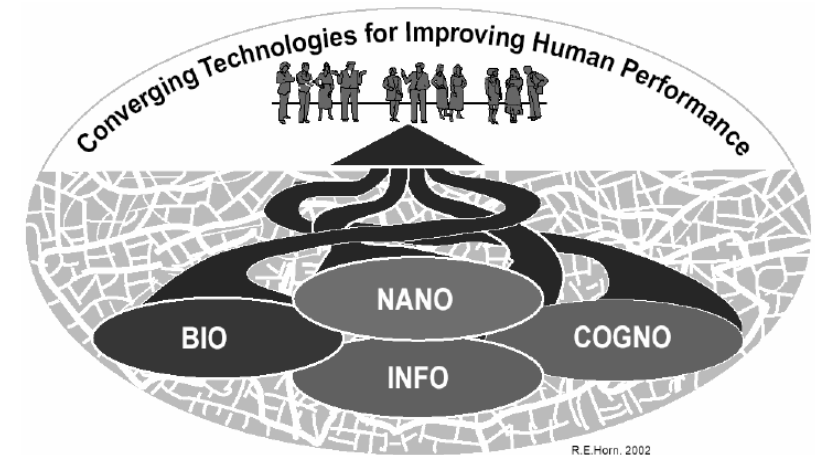


Funded by U.S. National Science Foundation and Department of Commerce; known as the **NBIC** report (Nanotechnology, Biotechnology, Information Technology, and Cognitive Science)



Roco, M.C., and Bainbridge, W.S. (eds) (2002) Converging technologies for improving human performance, NSF-DOC Report, Kluwer, 2003.

- Expanding human cognition and communication,
- Improving human health and physical capabilities,
- Enhancing group and societal outcomes,
- National security,
- Unifying science and education



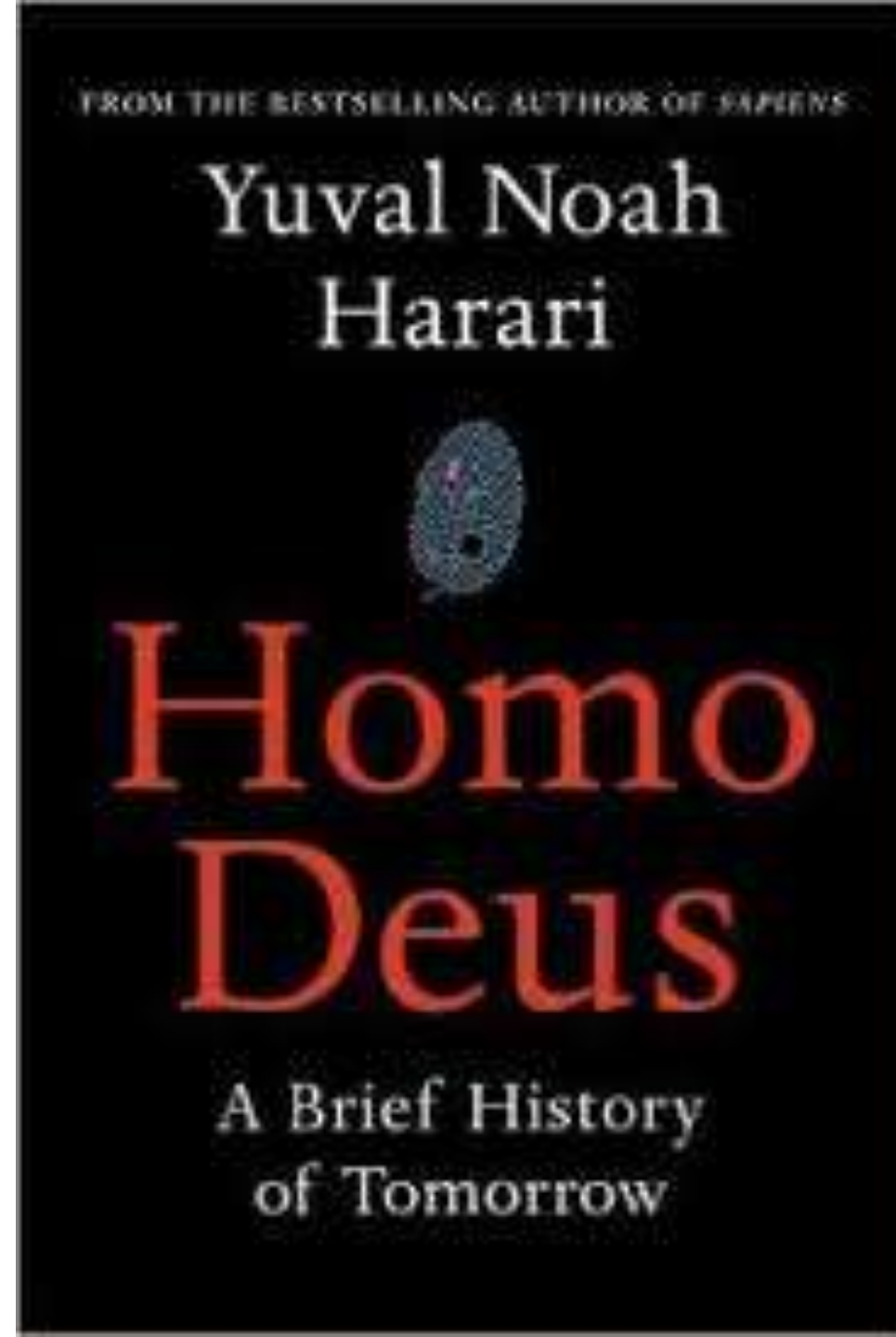
Harari's reading

“Solving death?”

“Upgrading humans into gods?”

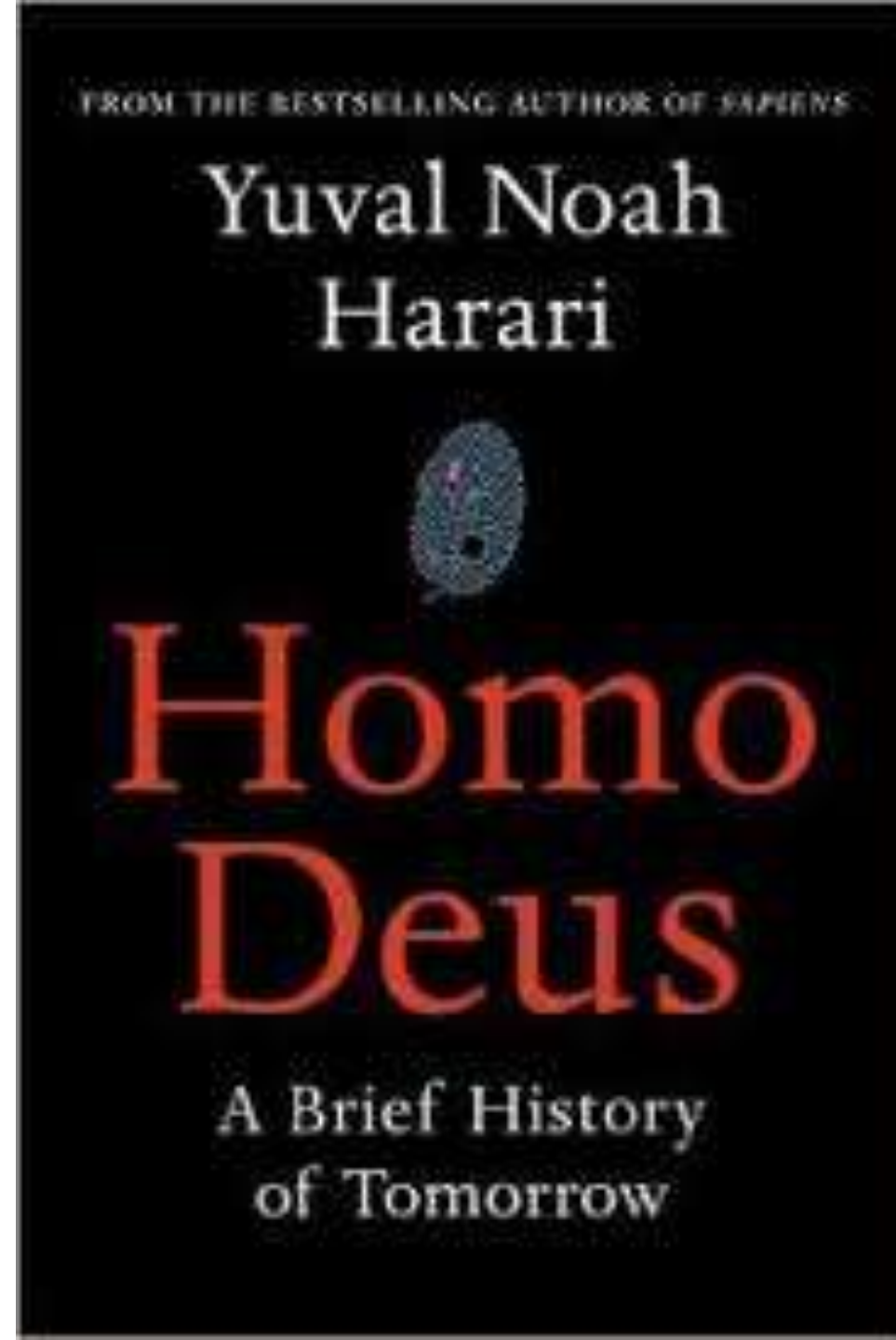
“Human bid for divinity certain”

“Nobody can hit the brakes”



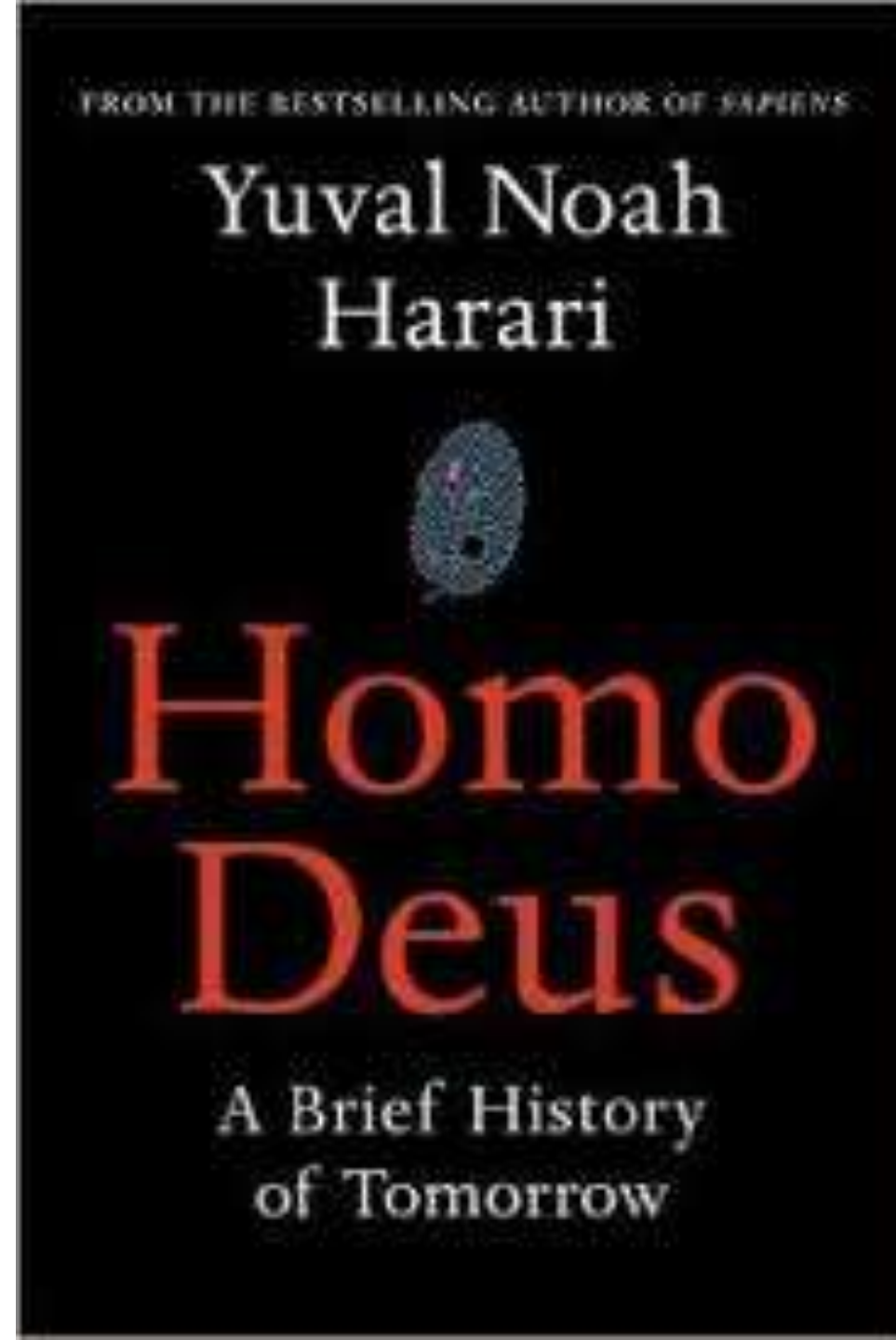
Harari's reading

“...human bodies will incorporate a host of biometric devices, bionic organs and nano-robots, which will ... defend us from infections...online 24/7 ...”

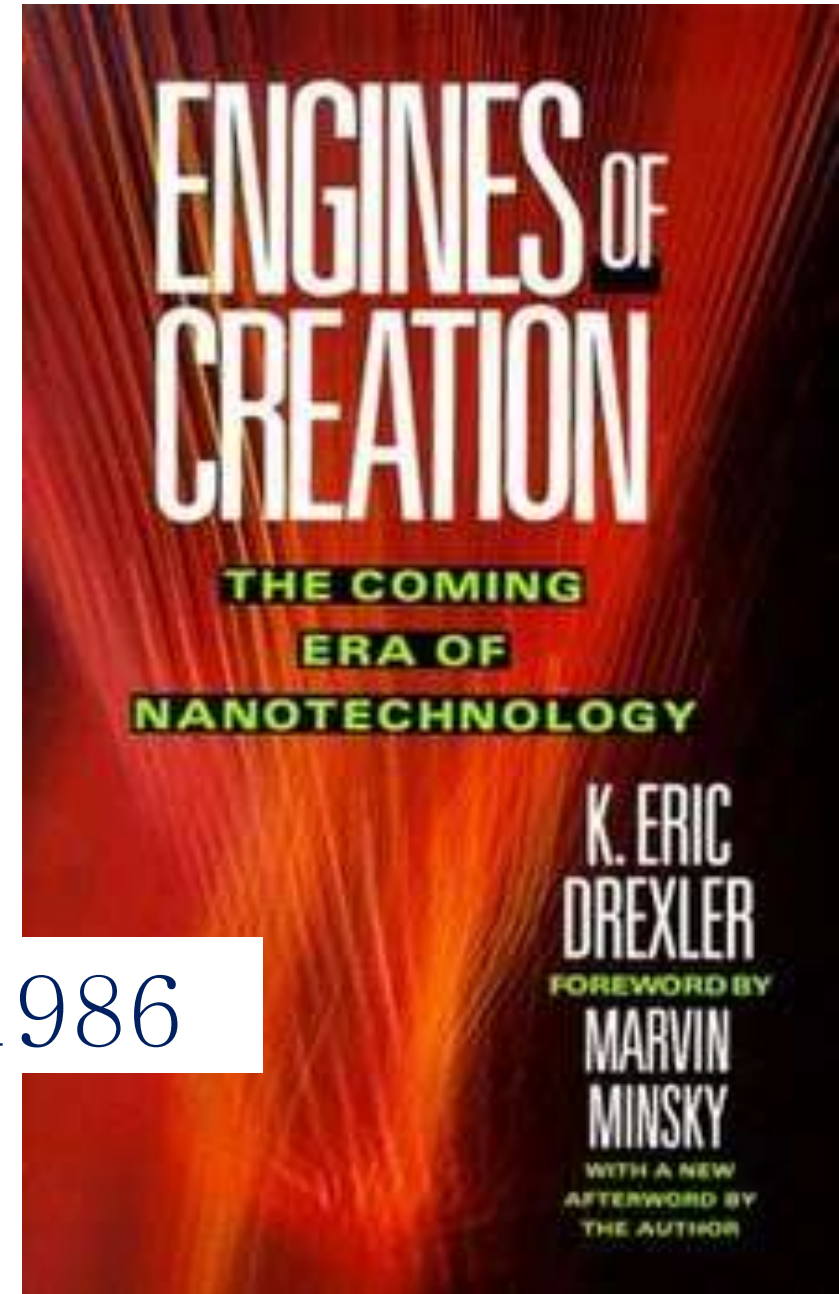
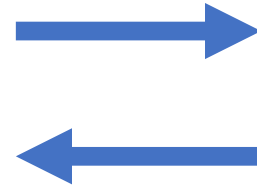


Harari's reading

“... if I don't upgrade my antivirus regularly I might discover that the millions of nano-robots coursing through my veins are now controlled by a North Korean hacker.”



Richard P. Feynman, There's Plenty of Room at the Bottom, Speech at Caltech, December 29, 1959.



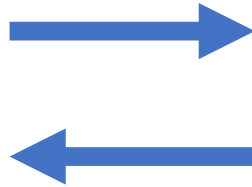
1986

https://en.wikipedia.org/wiki/There%27s_Plenty_of_Room_at_the_Bottom

See also <http://www.zyvex.com/nano>

Richard Feynman versus Erik Drexler

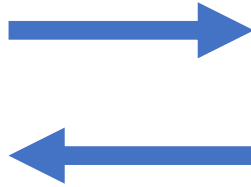
1959 versus 1986



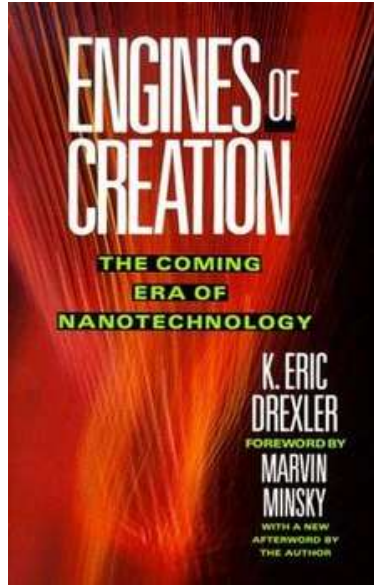
Both enthusiasts, and yet different worlds ...

https://en.wikipedia.org/wiki/There%27s_Plenty_of_Room_at_the_Bottom
See also <http://www.zyvex.com/nano>

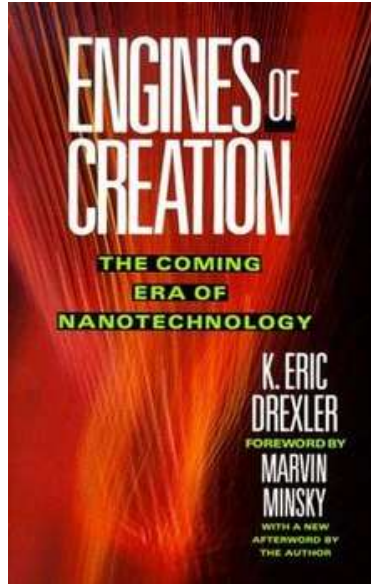
For both Feynman and Drexler nano
holds promises of wonders



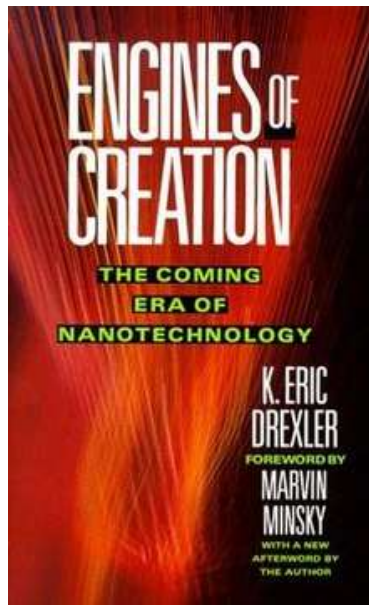
And yet Drexler sees dangers which
Feynman doesn't. Was the innocence
lost?



For Drexler (1986) nano will cure environmental degradation, postpone death, allow space travels, stop killer asteroids, solve the problem of nuclear waste, make 'Jurassic Park' possible, no more limits to growth, prosperity for all ...



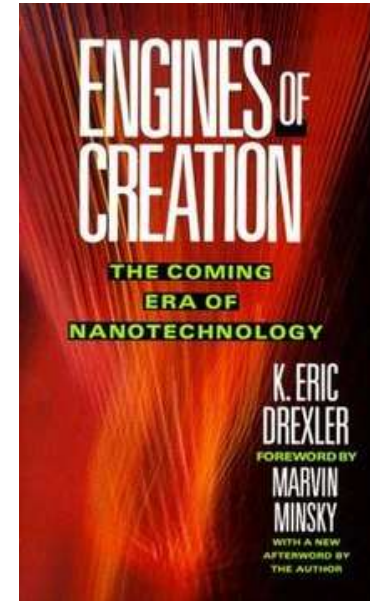
“... a world with machines that don’t clank, chemical plants that don’t stink, and production systems that don’t use people as cogs.”



Unlike Feynman, Drexler predicts nanomachines which can reproduce themselves

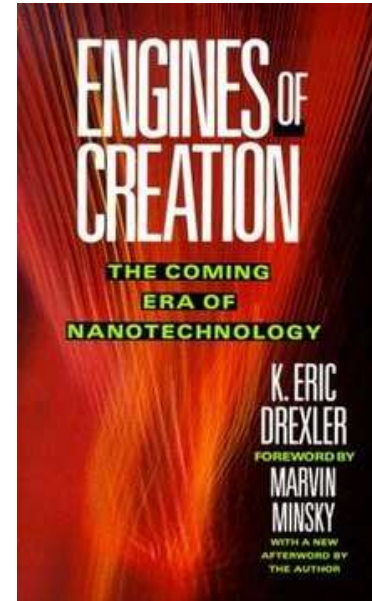
“As we look forward to see where the technology race leads, we should ask three questions: what is *possible*, what is *achievable*, and what is *desirable*”

“Will we develop monster technologies before cage technologies or after?
Some monsters, once loosed, cannot be caged”



Dangers ahead (in chapter 11 'Engines of Destruction')

- Grey Goo scenario
(a single accident fatal)
- Nano will favour
dictatorships against
democracies [see AI]
- Military applications almost
impossible to ban/control



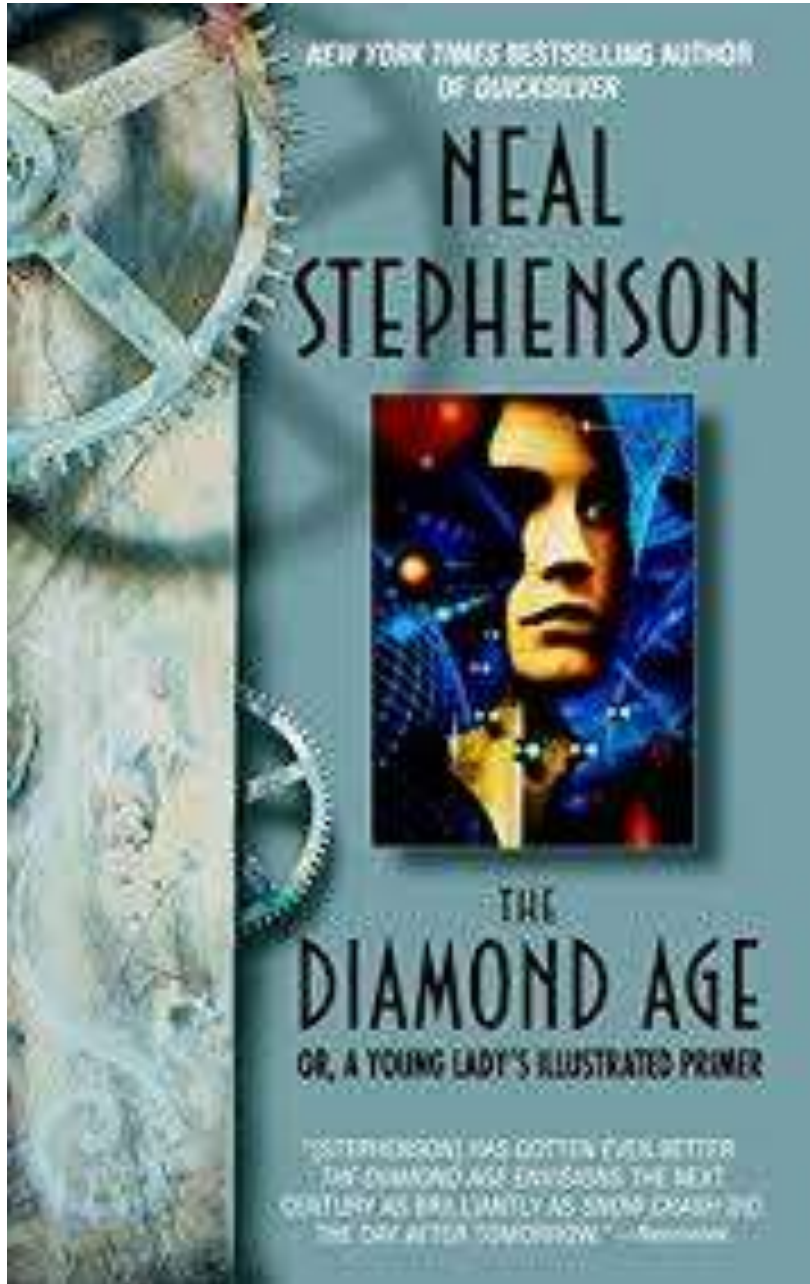


Feynman's battles in the Rogers commission for the Challenger disaster in 1986, see
<https://www.youtube.com/watch?v=4kpDg7MjHps>



Feynman: “not an accident”,
<https://www.youtube.com/watch?v=4kpDg7MjHps>

Fiction's corner



Neal Stephenson, The Diamond Age or a young lady illustrated primer

Tells the coming of age story of a marginal girl in a world of ubiquitous nanotechnology (on the tap, as well as airborne) with class, power and technology conflicts; Feynman and Drexler mentioned



Note: New social media making us ... worse persons in a popular book of Jaron Lanier

Black Mirror (Hated in the Nation)
Nano plus twitter in a sinister plot to educate the public against intolerance, the hard way



The End



@andreasaltelli